E-872

Using the Monte Carlo to determine the *Predicted* Neutrino Yield

R. Rameika

April 23, 1999

Purpose of this Note

- I have been working on making the Monte Carlo an general purpose tool for helping to determine the efficiency for locating neutrino interactions.
- Over the next several weeks I will report on the analysis of the MC and data and begin to extract efficiencies.
- There are many studies that need to be done in this area and I hope that others will begin to see how to use the MC to help in those studies.
- To get people started, next week I will post a general purpose ntuple which can be used to start studies.

Predicted Yields

- We can base our flavor yields (*before* efficiency correction) on the observed number ν_μ CC interactions:
  - $\nu_{tot} = CC_{tot} + NC$
  - $NC = 0.35\ CC_{tot}$
  - $CC_{tot} = \nu_\mu + \nu_e + \nu_\tau$
  - $\nu_\mu = \nu_e$
  - $\nu_\tau = 0.05\ \nu_{tot}$
  - $CC_{tot} = 2\ \nu_\mu + 0.05\ \nu_{tot}$
  - $\nu_{tot} = \nu_\mu + \nu_e + \nu_\tau + NC$
  - $\nu_{tot} = 2\ \nu_\mu + 0.05\ \nu_{tot} + 0.35\ CC_{tot}$
  - $\nu_{tot} = 2\ \nu_\mu + 0.05\ \nu_{tot} + 0.35 * (2\ \nu_\mu + 0.05\ \nu_{tot})$

$$\Rightarrow \nu_{tot} = 2.89\ \nu_\mu$$

Event Location Efficiency

- What contributes to the efficiency?
  - Spectrometer Performance
    - Trigger
    - Strip selection criteria
    - Visual scan selection criteria
    - Vertex reconstruction
  - Emulsion Scanning
    - Vertex location in module (u,v and z)
    - Number of tracks forming vertex
    - Angles of tracks forming vertex
- How can the efficiency vary within the experiment?
  - Neutrino types (topology)
    - ν_μ,ν_e, ν_τ, NC
  - Target Modules
    - ECC vs. Bulk;
    - station location
  - Time Dependence of Backgrounds
  - Time Dependence of Spectrometer Performance

Method for determining Actual Yield Predictions

- Define an efficiency for each neutrino type: ε_μ, ε_e, ε_τ and ε_{NC}
- For each neutrino type, each ε is the product of ε_{trig},ε_{strip},ε_{VS},ε_{scan}
- Use the Monte Carlo to determine ε_{trig},ε_{strip},ε_{VS}
- Monte Carlo each of the Target Configurations (period 1 - 4) to determine the gross time dependent efficiency due to the amount of target material present.
- Refine efficiency calculations by tuning the Monte Carlo to accurately model the data distributions

Monte Carlo and Data Comparison

- Detector Distributions
  - Tracking Detectors
    - No. of hits/plane
    - uv/xy hit distributions
    - Pulse height in SF
  - EM Calorimeter
    - No. of “hit” blocks
    - No. of clusters
    - Energy per block
  - Muon ID
    - No. of hits/plane
    - xy hit distributions

Monte Carlo and Data Comparison

- Reconstructed Parameters
  - No. of final spectrometer tracks
  - No. of SF lines
  - Total energy in calorimeter
  - EM energy per cluster
  - Muon ID per station
  - Vertex predictions
  - Prediction accuracy (located events
  - Angular distribution of tracks
  - Reconstructed momentum of tracks

Monte Carlo Refinements

- Use minimum bias triggers to study background levels as a function of time.
- Use MC/data comparisons to determine performance efficiency of detector elements such as trigger counters and MU ID.
- Incorporate dead channels and inefficiencies into MC and repeat trigger efficiency studies